THE INFLUE
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By Sir Lauder Brun

Paper introd
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THE INFLUENCE OF CLIMATE UPON HEALTH AND DISEASE.

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(Paper introducing a discussion on the subject at the Physiological Section of the British Association at Cape Town on August 16, 1905.)

Mr. President, Ladies, and Gentlemen,—The subject of climate is so important for the welfare of mankind that no words of mine are required to emphasise it. Yet it seems to me that it is not studied in the way its importance demands, and I ask your indulgence if, in introducing a discussion upon it, I venture to bring it before this scientific assembly in a somewhat different way from that in which it is usually treated, and raise questions for solution rather than impart information. Forty years ago, when I began to study the action of medicines, people were content to classify them in a general way as stimulants, depressants, tonics, astringents, alteratives, etc., without recognising that a medicine, such as opium, might contain several active principles, having not merely different but actually antagonistic actions, or knowing how each of these would affect the various organs of which the body is composed. Now we are able to distinguish between the actions of many of the components of our medicines, to define with a fair amount of exactitude their action on the several parts of the body as well as upon it as a whole, and thus to apply them with increasing certitude and even to modify them in the direction we wish, or make them according to our needs when they do not already exist.

It seems to me that the subject of climate is now treated in much the same way as that of drugs was treated forty years ago.

We speak of hot and cold, of moist and dry, of healthy and unhealthy climates, but we do not sufficiently differentiate the various factors which compose a climate nor their action on the various organs of the body.

Temperature and moisture are undoubtedly two of the most important factors, although they are far from being the only ones in a climate. Yet these depend not only on the distance of a place from the equator or poles, on its proximity to the sea or great lakes or rivers, or on its height above the sea level, but on its exposure to the sun, on its prevailing winds, on the nature and amount of its vegetation, on the inequalities of its surface, on its geological formation, on the amount and nature of its vegetation, on the electric conditions of its atmosphere, and on the number, character, and occupations of its inhabitants, who by agriculture, forestry, and drainage may alter it for the better or worse.

The whole subject is so complicated that it is only by careful, patient, and combined research that the various factors of climate can be ascertained, and their action and interaction upon one another as well as their influence on health and disease in man and beast can be understood.

The complexity and interaction of its various factors remind us of the connection which has been pointed out between the number of old maids in a district and the fertility of the clover fields. At first sight there is no apparent connection, but it becomes at once apparent when we fill in the intermediate links. The clover is fertilised by humble bees and the luxuriance of its growth depends on their number. This in its turn depends on the number of field mice which eat the bees, the number of field mice depends on that of the cats which kill them, and the number of cats on the number of old maids who keep them. The more old maids in a district, the more cats; the fewer mice, the more humble bees there are, and the more luxuriant are the clover fields. One might complete the cycle by saying that the more luxuriant the clover the more cattle will be fed, the more tillage will be required, the more young men will come to the district. and the fewer old maids will there be. Then will come another cycle ending in lessened fertility and increasing old maids, and these may go on alternately *ad infinitum* unless other factors should disturb.

Another instance of complex phenomena, involving not merely terrestrial but celestial influences, was given to me some years ago by Sir Norman Lockyer One man drew a curve of the number of sun-spots, and another a curve of the price of pork at Chicago. On comparison they were found to correspond. Here again there seems at first sight to be no connection between the phenomena, but the links are—the rainfall follows the sun-spots or perhaps, rather, the sun's prominences. On the rainfall depends the growth of grass, on the amount of grass the number of pigs which can be fed, and on the number of pigs the price of pork.

Factors in Climate.—In trying to analyse the intricate phenomena on which the action of climate upon health and disease depends we must remember that we have to consider:—

(1) Its action on the human body.

(2) Its action on the low organisms, vegetable or animal, which give rise to infective diseases, such as the bacillus of Enteric or the micrococcus of Malta Fever, the plasmodium of Malaria or the trypanosome of Sleeping Sickness.

(3) Its action on those forms of life which act as carriers of disease such as the mosquito of malaria, ordinary flies of enteric fever, and biting flies of Sleeping Sickness.

Influence of Temperature and Moisture on Cells.—Now the unit of all life, high or low, animal or vegetable, is the cell, variously modified and variously combined. A consideration of the action of various agents on cell life must, therefore, form the basis of any scientific investigation into the effects of climate.

As I have already said, temperature and moisture are two of the most important factors in climate, and we may begin by considering their effect on living cells in general.

For every cell there is a limit of moisture and of temperature beyond which it cannot exist, and an optimum at which it lives and flourishes best.

Dryness.—If moisture is completely absent the cell shrinks and dries up. In many cases it is killed by this process, but not in all, for the spores of many bacteria and micrococci, as well as the organisms themselves, survive complete desiccation, and again become alive and vigorous when the necessary moisture is supplied. The same is said to be the case with minute animals, such as rotifers. In the dry condition micro-organisms or their spores may lodge in clothes and be carried by animals or travellers, or be caught up as dust by the wind and be carried to great distances. The great plague of London, for example, was brought in clothes or carpets from Smyrna, and was also carried in the same way to a small isolated village in Yorkshire. The spores of anthrax are said to have been carried by the wind no less than 60 miles through a gap in a range of hills, and to have caused an outbreak of the disease in a farm lying in the line of the gap whilst other farms sheltered by the hills escaped. It is supposed that in the plains of Northern India the germs of enteric fever may be carried in this way to great distances, and give rise to outbreaks of fever without any direct infection being traced.

Moisture.—Too much moisture tends to make cells swell up, become distended and burst, but this process is, to a great extent, a function of osmosis, and is regulated by the proportion of salts in the surrounding liquid to those present in the cell itself. Pure distilled water applied directly to muscle or nerve is a powerful irritant poison and quickly destroys the life of the tissue, but if a small quantity of common salt be added (about ½ per cent.) it becomes innocuous. A strong solution of common salt again becomes as poisonous as distilled water. It is difficult to state the optimum of moisture or salinity for each cell though there can be little doubt that such an optimum exists. It may not, however, be always the same, for cells can be trained to live in fluid more or less saline than that to which they have been accustomed. If the salt water in which they usually live be gradually diluted, sea water amœbæ may come to survive in fresh water, and, conversely, fresh water amœbæ may be trained by the gradual addition of salt to live in sea water, although sudden change from salt to fresh or fresh to salt would prove fatal. Salmon also come from the sea to rivers, and pass from rivers to the sea, the cells in their gills becoming gradually accustomed to the change in the brackish water at the mouths of the rivers, although sudden change either from salt to fresh or fresh to salt would probably kill them. The relation between water and salts in the lymph which nourishes the cells in the bodies of higher animals, is kept fairly constant by the water drunk and that lost through the kidneys and skins, but it is probable that the cells may be trained to thrive with altered proportions of water and salts in the blood. People can certainly train themselves to drink less than their feelings of thirst would naturally prompt them to do. The general consensus of opinion seems to show that Europeans in hot climates are better if they restrain their desire to drink at all times of the day and only quench their thirst at meal times. If we look for an explanation of this fact we may find it in the consideration that in hot climates we require, if possible, to lessen tissue metabolism which the higher temperature constantly tends to raise above the normal. It has been found that copious draughts of water increase tissue metabolism of the body at ordinary temperatures, probably by diminishing the salinity of the blood, and it would therefore seem advisable to use water sparingly. But, on the other hand, water is absolutely necessary to supply the cutaneous evaporation by which the body temperature is prevented from rising too high and for removing the products of nitrogenous waste. In order to obtain some definite guide to the proper adjustment of water to the needs of the organism we require a series of observations on the specific gravity of the blood, the amount of nitrogenous waste, and the temperature of the body along with the amount of foods and water, and the temperature and moisture of the atmosphere. Such observations, however, to the best of my knowledge have not yet been made, and perhaps the British Association might originate such a research.

Cold.—Turning now to temperature, we find that unicellular organisms appear to bear, without injury, any cold that it is possible to apply, so that to Lord Kelvin's hypothesis that life came to this earth from some distant planet one cannot raise the objection that it would be destroyed in its transit by the cold of space.

Heat.—Extreme heat on the contrary will kill every living thing. Some algæ are said to live at the temperature of boiling water and some spores may resist a dry heat of even 140° for a short time, but most micro-organisms are quickly killed by a moist heat of 75° C. to 80° C. in a few minutes, or by a lower temperature for a longer time, such as 60° C. for an hour. A higher temperature is required to kill the spores than suffices to kill the microbes themselves, and thus repeated heating with sufficient time between to allow the spores to develop, is the most efficient means of destroying them.

The optimum of temperature for the cells composing the human body is about 98°·4 F. or nearly 37° C. When the temperature falls below this the muscles contract more slowly and feebly, the nerves transmit impulses less quickly and less perfectly, the nerve cells become less active and metabolism is diminished, so that persons exposed for too long a time to very severe cold become feeble, drowsy, and die. The enfeeblement of the muscles is seen to a slighter extent in the stiffness of the fingers on a cold day, and Professor Sims Woodhead informs me that his record for a 100 yards race was one-fifth of a second better in summer than winter and even a cold wind in summer will lower the record for all athletic performances. The lessened metabolism diminishes the production of heat, so that if a person has been cooled down by prolonged immersion in a cold bath, the temperature tends to fall still farther after the bath is over.

As the temperature rises within certain limits, the muscles contract more quickly and strongly and the nerves transmit impulses more rapidly. It would appear that a temperature slightly above that of the human body is the optimum for a short time, but while this raised temperature increases excitability, it lessens vitality and, if long continued, hastens death. If the temperature rise above a certain point it tends to produce in all contractile cells a spasmodic condition known as heat-tetanus. If the cells be cooled down in time this condition gradually disappears, but if the temperature should rise the tetanus becomes converted into rigor and the cell dies.

Regulation of Temperature in the Body.—In spite of the extremes of cold and heat to which human beings are exposed in various parts of the world, the cells of which their bodies are composed are kept at a fairly even temperature. In cold climates the body heat is retained by warm clothing and by small and nearly air-tight houses where fuel is scarce and it is added to by the artificial heat of lamps, fires or stoves as far as possible.

As Rosenthal has shown, the intestines act to some extent as a regulator of the body temperature. They contain a large quantity of blood which is only separated from the external air by the thin abdominal walls and by the clothes. When the air is cold both animals and man tend to draw their legs up so as to cover the abdomen with the thick muscles of the thighs and thus retain the heat which would otherwise be lost.

At the same time that heat is retained more heat is generated, for it has been shown experimentally that external cold increases tissue change, so that the animal gives off more carbonic acid and excretes more urea so long at least as it is able to maintain its ordinary temperature, for should this fall tissue change is diminished and the temperature falls still lower, as I have already mentioned when speaking of the effect of cold generally.

Food.—To maintain this increased combustion more food is required and increased appetite not only ensures the consumption of a larger quantity of food, but a desire is felt for fatty foods which, weight for weight, yield more calories than either proteids or carbohydrates.

Exercise.—When the food is abundant the body generates a considerable amount of heat even when at rest, but exercise greatly increases tissue change and the production of heat. Haldane and Pembery have found that after a brisk walk the temperature of the body may rise as high as 102° F. and when walking is impossible, involuntary muscular action may take its place and, as a friend of mine told me he had done in Canada with a temperature 40° F. below zero, they may " shiver themselves warm."

Effects of Heat.—External heat tends to raise the temperature of the body in spite of all the means of keeping it down to normal, and Crombie has shown that the average temperature of Europeans in India is nearly half a degree Fahrenheit above the normal in England, and Professor Ruffer has found it rise in his mouth to 101·8 F., when riding in a hot sun without any further exercise than that due to the shaking of the camel. One of man's first instincts in hot climates is to protect himself from the direct rays of the sun and sometimes unpleasant consequences ensue from neglecting to do this.

Production of heat in the body is lessened by the diminished supply of food to it caused by the failing appetite.

But production of heat is still further lessened by the diminished exercise which the lassitude in hot climates enforces, and this is evidently a safeguard to prevent the increased tissue-change and rise of temperature which are caused by the hot climate itself being increased by exercise to a dangerous or fatal extent.

Increased Loss of Heat—Perspiration.—The most important provision against an excessive rise of temperature, however, consists in increased loss of heat from the body. A not inconsiderable amount is given off by the lungs, as everyone knows who has warmed his fingers by blowing on them on a cold day. But this quantity is small compared with that given off from the skin. In hot weather the natural tendency is to adopt an attitude exactly the opposite of that which is assumed in cold, and to throw the arms and legs wide apart whilst the trunk is extended so as to expose the abdomen as much as possible to external cooling influences. Much heat is carried off by conduction, especially if the air is kept moving over the surface either by a natural wind, by fanning, or by the motion of the person from place to place. Warmth dilates the vessels of the skin, and thus the blood, instead of remaining in the interior of the body, is kept circulating on the surface and cooled. But the cooling effected by mere conduction would be quite inadequate to keep the body heat within normal limits were it not that evaporation of sweat from the skin converts it into an actual cooling machine. So great is this action that in some experiments by Sir Charles Blagden he found the skin of some men who were standing in a hot baker's oven to be actually cold to the touch. But in order that this cooling mechanism should act it is necessary that the surrounding air should not be saturated with moisture, and that it shall be to some extent in motion. For even when the air generally is not saturated the layer of it next to the skin soon becomes saturated, and unless replaced by a fresh supply evaporation ceases and cooling stops. The nearer the moisture in the air approaches the point of saturation the less efficiently does the cooling apparatus work, and the more danger is there of the temperature rising above the danger point.

Heat Apoplexy.—In consequence of this more cases of heat apoplexy, as Professor Ruffer informs me, occur on cloudy than on clear days, and many do not occur in the hours of sunshine but after the sun has set, and the air, though cooler, is more nearly saturated with watery vapour. The cooling of the body is thus prevented while more heat is being generated by tissue metabolism, and the temperature rises until it is incompatible with life. Danger of such a result is of course increased by anything that increases the formation of heat in the body such as previous over-exertion, or fever from any cause such as digestive disturbance, inflammation, or infection.

As I have already mentioned, Haldane and Pembery found that a brisk walk might raise the temperature even up to 102° F., and the effect of the exercise upon soldiers was much influenced by their costume. When they wore a light khaki suit the distress and fever produced by the quick march was much less than when they wore ordinary uniform and stiff belts.

Over-exertion must be regarded as predisposing to heat apoplexy, but, on the other hand, complete inaction appears to have a similar effect. Professor Ruffer informs me that guinea-pigs exposed to the sun soon die if they are in small cages so that they cannot move freely, while they are not injured by similar exposure if they are allowed to run about. He also tells me that sentries on duty are much more liable to sunstroke than others. The explanation he gives of these facts seems very probable, viz., that slight exercise stimulates the circulation and causes the sweat glands to act more freely, so that a dangerous rise in temperature is prevented.

Alcohol.—Excessive use of alcohol also predisposes powerfully to heat apoplexy. It probably does so by its paralysing effect on the central nervous system, as large doses of narcotics destroy for a time the power of regulating the temperature, so that it rises or falls quickly according to that of the surrounding air.

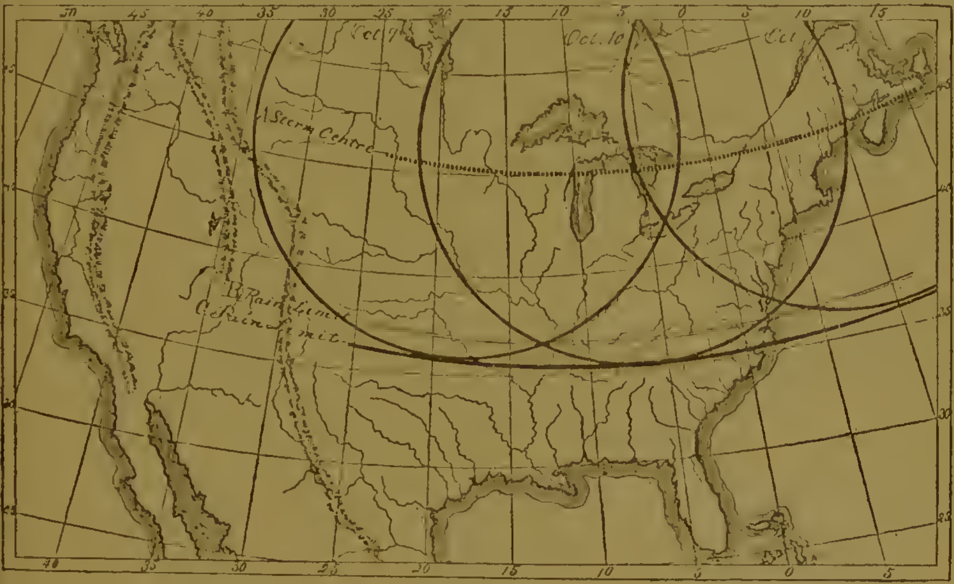
Soil.—Both temperature and moisture are affected by the nature of the soil. If it is porous the air over it it will be drier and warmer than if it is dense.

The soil also affects the health by means of the saline ingredients it imparts to the water used for drinking and cooking, and the effects of the water are sometimes put down to the climate. Thus I have been sometimes told by people that "sea air did not suit them," when enquiry convinced me that the statement was based upon the fact that they did not feel so well at certain places on the southern shore of England. But the real cause of this was that as these places were situated on the chalk the water contained much lime, and caused constipation, with its attendant troubles.

Vegetation.—This depends on the nature of the soil and on the temperature and moisture of the atmosphere, but in its turn it influences the latter, increasing the moisture when it is luxuriant.

Winds.—Winds have a powerful action, intensifying the effect of cold or hot air. Thus a cold wind chills the body much more than still air at the same temperature, and if it be moist as well as cold its chilling effects are greatly increased. A hot wind, such as occurs in desert regions, imparts much more heat to the body than still air at the same temperature, but at the same time it causes more rapid evaporation, and whilst this may keep down the body temperature it cracks the skin, irritates the mucous membrane, and causes great discomfort and nervous irritability, especially if it carries sand or dust with it as is often the case. In Capri, when the sirocco is blowing, the priests are often up the whole night trying to avert quarrels, and if one man murders another the presence of this wind is considered as an extenuating circumstance. Cool or moderately warm breezes in a hot climate are, on the contrary, refreshing and invigorating if dry, and soothing if moist.

Electrical Conditions.—In regard to the effect of electrical conditions on health, but little is known positively. The dulness, depression, and the headaches which frequently precede a thunder storm, and the relief which is experienced when the storm is over, are matters of common observation. A number of years ago Weir Mitchell noticed that many of his old patients suffered from pains in such a way as to indicate that a pain storm was crossing the American Continent. On comparing their complaints with meteorological records, he found that a rain storm was crossing America at the same time and at the same rate. The rain areas and pain areas were concentric, but the pain area was much larger than the rain area and extended a considerable distance beyond it in every direction. In consequence of this, those living in the rain area might look up and, seeing the rain, might attribute their pains to the weather, whilst those living in the pain area would be puzzled to account for their pains, although these were due to meteorological conditions just as much as those in the rain area. What those conditions were have not yet been completely determined, for although moisture, temperature, and barometric pressure all took part, there was something besides, possibly electrical changes. Another observation



of great interest also made by Weir Mitchell is that the curve showing the number of cases of chorea in his clinic in Philadelphia nearly coincided with the curve showing the number of storm centres which passed within a radius of about 450 miles of the city. It is probable that electrical conditions also influence the condition of the nerve centres in other respects, and exert an influence on so-called voluntary actions, but Dexter[*] thinks that barometric pressure is the most powerful factor in such action. According to him a low barometer is characterised by increase in crime, insanity, bad conduct, sickness, and suicide, whilst drunkenness is diminished and clerical errors by bank clerks are slightly fewer, attention either being increased or greater precautions taken to avoid them; dryness of the air lessens intoxication and mental inexactness, but increases all forms of active disorder and suicide. In cold months sickness, death, and drunkenness are more frequent; in summer crime and suicide. Hot weather tends to destroy the mental balance in females more than in males. Calms depress vitality and lessen crime, insanity, and bad conduct, but increase sickness, death, want of attention, and absences from school. The results of his researches have thus been summed up by Dr. H. R. Mill.[†] "Crimes of violence and bad conduct in school or in prison are due to excessive vitality imperfectly controlled, and their frequency is increased by whatever conditions of weather increase vitality; while illness, insanity, and death result from deficient vitality, and work greater havoc when depressing atmospheric conditions prevail."

Rainfall.—Closely connected with electrical conditions is the rainfall. This may be great, and yet the general humidity of the atmosphere may be comparatively small or the rainfall may be small and the humidity great. After a rainfall the moisture in the atmosphere is diminished, the air is washed clear of dust and germs, and generally men feel better and more comfortable. Thunder storms are said to "clear the air," and where they are frequent the climate is likely to be much more healthy than it would otherwise be.

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[*] *Weather Influences*, by E. G. Dexter, London and New York: Macmillan.

[†] Symons' *Meteorological Magazine*, vol xxxix, 1904, p. 225.

Barometric Pressure.—I need not discuss here the effect of increased barometric pressure, for with the exception of the Jordan valley, there are few spots on the earth's surface where such a condition exists. Diminished barometric pressure occurs whenever we rise above the sea level, and is proportionate to the rise.

A sudden diminution of pressure such as occurs in a balloon ascent is apt to cause sickness, giddiness, unconsciousness, hæmorrhage and even death.

When one ascends gradually a feeling of lightness and exhilaration is felt, the pulse becoming quicker and the respiration deeper as the height attained increases.

At heights below 5,000 feet it is unusual for healthy people to feel any discomfort and, indeed, Mr. Douglas Freshfield informs me that he has walked at a height of 16,000 to 18,000 feet in the Himalayas without discomfort.

Many opinions have been held regarding snow sickness. It seems to me that it is due in great measure to distension of the pulmonary capillaries, right side of the heart, and nervous system generally.* For severe exertion, even at the sea level, causes a similar condition which is often observed in athletes after a severe strain in running or rowing. At high altitudes the congestion of the pulmonary capillaries, which exertion naturally produces, will be increased by the diminished support given to them by the atmospheric pressure in the pulmonary alveoli, while the pressure within the vessels, depending, as it does, on the force of the heart, will remain undiminished.

Continued residence at heights of 5,000 to 6,000 feet appears to cause increased formation of red blood corpuscles and of hæmoglobin and to augment the strength, activity, and endurance of the person.

Light.—At high altitudes the effect of light on the body is much increased, many of the rays in the upper part of the spectrum acting upon it while they are filtered out at lower levels by the thicker air. This is well seen in the great browning of the skin noticeable in the Swiss mountains. The action of light appears to increase tissue metabolism. Frogs exposed to it give off more CO_2 and absorb more oxygen than they would in the dark, other conditions being similar, and the same holds good for rabbits. In them, however, the stimulation appears to take place through the eyes, for if these be covered the increase is slight or absent. There can be little doubt that sunshine has a stimulating action on man, while darkness is depressing, and in considering the effect of climate on human action as well as on health this factor should not be neglected.

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* Lauder Brunton on "Breathlessness," *Practitioner*, June, 1905.

Influence of Climate on Health.—We must now turn to the consideration of the effects of the various factors of climate on the health of man. In doing this we have to remember that the weakest part of the body is liable to be first attacked, and that the weakest part is not unlikely to be that which is subjected to much strain at the time. Thus gout usually attacks the joint of the big toe, because there is no other joint in the body subjected to the same amount of action and strain. But I have seen it attack the wrists of a man who used them much in his work of polishing furniture, and the shoulder in a workman who had to swing his arm round in whitewashing. Pasteur's experiment on anthrax in fowls is most instructive. Fowls have a normal temperature of 104° F. and are not susceptible to anthrax. But if they are made to stand in cold water until the chill has lowered their temperature before inoculation they take the disease and die.

Pneumonia usually follows so distinctly upon a chill that it used to be regarded as a typical instance of the effects of cold. We now know that it is an infective disease due to micrococci. These are often present in the throat and tonsils, but like the anthrax bacilli in Pasteur's experiment, they do no harm until the vitality of the patient has been reduced by a chill, when they grow, multiply and induce fever with inflammation of the lungs. In all probability most catarrhs are due to micro-organisms acting upon organs whose vitality is lowered either by chills or some other depressing condition. When air is cold it tends to chill the nose and respiratory passages, but if dry its chilling action is slight. When it is cold and moist it carries away much heat and is therefore apt to chill the respiratory passages and produce catarrh of the nose, pharynx or trachea, bronchitis or pneumonia. This effect is all the more likely to occur if the vitality has already been depressed by heat or over-exertion and thus pneumonia is apt to prevail in hot climates with clear cold nights, and nasal or bronchial catarrh to come on when exposure to cold moist air occurs after some time has been spent in a hot close atmosphere. Tubercle bacilli grow very slowly, and if inhaled by healthy people will be expelled from the air passages before they can find a footing, but if a suitable soil has been prepared for them, either by bronchial inflammation or pneumonic consolidation they may grow, multiply, and destroy the patient. In hot, moist climates sleep is often disturbed and restless, so that the bed clothes, if any, are thrown off and the surface of the abdomen is exposed. The thin walls of the abdomen alone are insufficient to protect the intestines from chills, and unless a cholera belt or camarband is worn gastro-intestinal catarrh is apt to come on or dysentery if the germs of that disease are already present in the intestine. Chills to other parts of the body may also produce depression, and a cold draught behind the ears, on the back of the head or on the shins may cause depression and produce catarrh, either of the air passages or digestive tract. In persons who carry the malarial poison in their body such chills may bring on a return of the fever even when they have been free from it for a considerable time, and thus patients are more liable to attacks in hot climates with cold nights than in those which are moister and more equable, although the latter give rise to greater languor and general depression. It is probably for this reason that cases of chronic malaria often feel better in the hot plains of India than in the hills although a long sea voyage in the cooler but yet warm and moist air of the tropical seas is very advantageous to them.

Continuous residence in the tropics tends to produce lessened vitality, anæmia, and hepatic disorders. The anæmia may be due both to lessened formation and increased destruction of blood corpuscles. The anorexia which is felt in hot climates will tend to lessen production, while the insomnia, restlessness, and high temperature of the body will increase their destruction.

The excessive action of the skin tends to produce prickly heat, and probably favours the appearance of boils.

Disease Germs.—Although disease germs, when once introduced into the human body, may find there an optimum of temperature and moisture, and thus, like the *plasmodium malariæ*, live in it for years after the first infection, yet outside the body disease germs are limited in their geographical distribution by climatic conditions. Thus scarlet fever, though often introduced into India, does not flourish there, and though a case of dengue may occasionally be found in England, it does not become epidemic. The plasmodium malariæ does not thrive at a mean temperature of under 70° F. nor over 86° F., and the germ of yellow fever does not grow in cold climates.

Strong sunlight is destructive to most disease germs, and even diffuse daylight greatly lessens their vitality. Ozone, which is present to the greatest extent in the air on the ocean, at the seaside, and in the neighbourhood of pine forests, in desert plains and high mountains, is also very inimical to disease germs. Its quantity in the air is increased by strong sunshine and by thunderstorms.

Carriers of Disease.—Two of the most important discoveries in regard to the conveyance of disease are that of the communication of malaria to man by the mosquito and of the Sleeping Sickness by the biting fly (*Glossina palpalis*). The former we owe chiefly to Manson and Ross, and the latter to Bruce. Yellow fever also is transmitted by mosquitoes, by ticks, and probably plague by fleas. The *rôle* played by flies in spreading Egyptian ophthalmia is well known.

By the use of fine wire netting to exclude mosquitoes from houses, and of curtains and veils to keep them off the body, malaria can be very greatly lessened, as has been well shown in the Campagna of Rome.

By draining puddles so as to destroy the breeding grounds of the mosquito, and by pouring paraffin oil over the water in places insusceptible of drainage, so that the mosquito larvæ are choked, the healthiness of some places has been greatly improved.

Influence of Particular Climates in Causing or Curing

Disease.—In considering this subject it may be convenient to consider it rather from the nature of the climate, hot or cold, moist or dry, elevated or depressed, than from that of the disease.

We may therefore divide them according to the following table:—

Very cold ...	dry. moist.
Very hot ...	dry. moist.
Sea climates ...	ocean. island. seashore.
Inland climates	valley. plain. mountain.

Very cold climates, which from their very coldness are dry can be borne with impunity and without any impairment of health or vigour, bodily or mental, provided proper precautions be taken in regard to warm clothing, avoidance of alcohol and proper supply of food. This has been shown by the experience of many arctic explorers and also by the recent example of the cruise of the "Discovery."

Cold and moist climates are depressing to the general vitality, and are specially apt to injure the respiratory organs and cause bronchial catarrh and phthisis. Such climates, however, may breed very hardy races, such as Norsemen and the Scotch Highlanders. Cold climates, especially where combined with a damp soil, are very apt to cause rheumatic diseases and the arthritic and cardiac affections consequent upon them. Wind increases the effect of cold, whether dry or moist. Its effect depends on the rapidity with which it can withdraw heat from the body and the power of reaction possessed by the person. If the amount of heat withdrawn is only such as the person can lose without inconvenience, a wind tends to stimulate, but if the removal of heat be too rapid or great, depression and disease are apt to ensue.

The curative effects of cold climates depend much on the strength of the patient, as well as on the actual temperature, moisture, and wind. As has been already mentioned, they are apt to bring on chills in persons suffering from malaria, yet when such patients have had their power of resistance increased by moderate temperature and sunshine, a dry cold climate may complete the restoration to health and strength. The same rule holds good for patients suffering from general debility, nervous and digestive disturbance, or pulmonary weakness. Very hot climates tend, as already mentioned, to lower vitality, produce anæmia, and to lessen resistance to disease, so that any acute disease is apt to run a more rapid and fatal course than in more temperate climates. Much moisture along with great heat increases this tendency and, in addition, gives rise to heat apoplexy with great frequency.

Sea Climates.—In cold climates life on the ocean is unsuited, as a rule, for invalids, for unless they are strong enough to keep warm by exercise, they are apt to suffer much from cold, their vitality is depressed, and any disease from which they may suffer is apt to become worse instead of better. In the hotter parts of the earth's surface the temperature on the ocean is modified by the coolness of the sea itself, and especially by cold currents in it, as well as by winds. To what an extent the heat may be modified by winds has been well shown by the experience of the members of the British Association on their voyage to South Africa in the "Saxon," for all through the tropics rather warm clothing was agreeable, and on the night they crossed the line a number of them were obliged to rise in order to get blankets or rugs to cover them. But, as a rule, the complete rest on board ship, the freedom from letters or telegrams, the sunshine, and the gentle exercise give a sense of wellbeing and an appetite which leads the patients to eat well. Such conditions are admirably suited to restore convalescents to health and to give strength, bodily and mental, to neurasthenics or persons who are broken down by work, worry, anxiety, or sorrow.

The freedom from germs makes it very suitable for persons suffering from hay fever, or for cases of weakness of the lungs where phthisis may be apprehended but is not actually present, and where residence in a sanatorium for phthisis is thought undesirable on account of the possible risk of infection.

Island climates, such as the Canaries, are somewhat the same in their general characters as ocean climates, but there is not the same complete isolation nor the same compulsion to spend almost the whole time in the open air. For some patients the less complete isolation may be beneficial, and it allows of a longer residence without *ennui,* but it is less useful for neurasthenics.

Seashore climates share to some extent the advantages of ocean or island climates. There is generally a land breeze in the day and a sea breeze at nights. There is apt to be a greater difference between the temperature of the day and night than on the ocean or on small islands, and thus greater care must be taken to avoid chills.

Of *inland climates* the two most important are those of the plains and mountains.

Plains, as a rule, are dry and the extremes of heat and cold are well marked. From the dryness they may suit cases of pulmonary disease, either catarrhal or phthisical, but the advantage which phthisical cases derive from life on plains is probably due in great measure to the sunshine and to their being constantly in the open air.

For in phthisis the bacilli which cause the disease have obtained a lodgment in the lungs, and all the remedies hitherto employed for the purpose of destroying them in this situation have failed. We are therefore forced to depend on the plan of increasing the vital powers of the organism to destroy them.

In the plan followed at Nordrach this end is attained at a moderate altitude by making the patients live in the open air as much as possible day and night, and by forced feeding when natural appetite is deficient.

At the health resorts in the High Alps the patients naturally tend to remain all day in the open air, for the air is so still that there is no chilling wind and there is just a sufficient nip of cold to encourage exercise. It is quite possible that the lessened pressure in the pulmonary alveoli may encourage circulation through the capillaries of the lung and that thereby phagocytosis may be increased, tubercle bacilli consequently diminished, and damage to the pulmonary tissue repaired more rapidly and efficiently than at lower altitudes. This is, however, another of the questions which requires for its solution many more observations as well as exact experiments.

In this introductory paper I have said nothing about the climates of particular places, and I leave it to those who are to take part in the discussion to decide what places are to rank as the great climatic health resorts of Africa, either present or future. It may be that Africa will become the greatest climatic health resort in the world, and that the Mountains of the Moon will become a household word instead of a vague abstraction. The object of the paper has been to stimulate to farther research rather than to instruct, for this I believe is the function of the British Association.

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